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ABSTRACT

Literature dealing with the disadvantaged is cursorily reviewed and questions raised by the literature are considered. Specifically, this study concerns the relationship between social class and the rate of processing of visual information in young children. Although various sources of slowness in learning are mentioned, this study focused only on basic cognitive processes, viz. the duration of time required by the child's perceptual system to process visual information. Subjects were 30 first graders from an advantaged (middle-upperclass) school and 30 first graders from a disadvantaged (lower class) school. A Berbrans two-field tachistoscope was used for estimating the processing rate. Techniques developed by Gilbert for controlling image persistence (based on the masking effect of a second visual stimulus) were modified in order to make possible more precise measurement and control. The entire measurement procedure is fully elaborated. The study concludes that: (1) young children of low social class can be tested using the tachistoscope; (2) the four stimuli used (circle, star, square, and triangle) were appropriate for testing young children; and (3) children from a low socioeconomic background do exhibit slower processing rates. (TL)

SOCIAL CLASS AND THE INFORMATION PROCESSING RATE OF YOUNG CHILDREN

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The basic purpose of this investigation was to estimate the relationship between social class and the rate of processing of visual information in young children. A frequent assertion in the literature dealing with the disadvantaged is that children reared in such environments tend to be "slow learners." Riessman, whose book, The Culturally Deprived Child, has had considerable influence, contends that "the deprived child typically works on academic problems in a slower manner." According to Riessman, the disadvantaged child's environment promotes a cognitive style which may be characterized as slow and deliberate. The slow learner, although not necessarily a poor learner, may become such as a result of the treatment he is given in the schools. (Riessman, 1962). Others, such as Crow, Murphy, and Smythe (1966), Beilin and Gotkin (1967), Rees (1968), and Johnson (1966), have made similar assertions.

Reflection on this position raises these questions: What is the slow learner? And, to what extent is social class associated with "slow learning?"

What factors account for the extra duration of time required by some learners to master a learning task? Does the "slow learner" tend to have a shorter attention span and spend greater amounts of time on distracting stimuli? Does he require more redundancy in learning situations? Or, are his basic cognitive processes slower? Generally, the "slow learner" is identified as the child who scores low on achievement tests. To say that the slow runner is the individual who crosses the finish line last is to say little about factors which explain his performance. In much the same way, low scores on achievement tests generally reveal little about the nature of the learning difficulties. Also, the use of an achievement test

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scores to identify the slow learner does not enable distinctions between slow learners and poor learners if such a distinction is useful. Unfortunately, analyses of the nature of slow learning or conceptualization of the "slow and deliberate" cognitive style tend frequently to be circular or very sketchy.

This investigation will focus on the last of the three above mentioned possible sources of slowness in learning--basic cognitive processes. More specifically it will deal with the duration of time required by the child's perceptual system to process visual information. Selection of this variable is not meant to imply that slowness in learning is solely attributed to slow rate of processing information. Other factors (such as those mentioned above) may also contribute. Or, perhaps, there are several types of slow learners each type resulting from different factors. The following explanation should make more clear the meaning of the information processing rate.

Generally, investigations of the recognition threshold of visual stimuli have involved successive tachistoscopic presentations of stimuli and the selection of a point on a time scale according to an established criterion as the threshold for the subject. Such measures may be spuriously low because of the persistence of the image in the central region of the nervous system after the termination of the test stimulus. This phonemonon has been discussed by various individuals and given different names: "memory after image" (Gilbert, 1959) "stimulus trace" (Hull, 1943) "icon" (Neisser, 1967). A technique for controlling for the effects of the "icon" was developed by Gilbert (1959). This technique is based on the notion of the masking effect.

Research has well established that the perception of a visual stimulus may be inferred with or masked by the presentation of a second visual stimulus (Sperling, 1960; Averback and Coriell, 1961). The second stimulus appears to erase the information held briefly in a visual short-term storage system. The phenomenon is also widely referred to as the erasure of an icon. (Neisser, 1967).

The minimum time that must be allowed between the initiation of the first stimulus and the appearance of the erasing stimulus in order for recognition of the first stimulus to take place is referred to as the minimum interval for recognition. It represents the time required to process the incoming batch of information to the point where the recognition can take place.

In a series of investigations at Western Michigan University, the techniques utilized by Gilbert (1959) have been modified in order to make possible more precise measurement and control. (Travers and Bosco 1967; Bosco, Travers, and Wilkins, 1968; Wilkins, 1968). The processing rate calculated using these procedures is a measurement of the speed of cognitive functioning in visual perception. Estimates of the information processing rate are obtained by tachistoscopically presenting stimuli to the subject. The minimum time that must be allowed between the first stimulus (test stimulus) and the appearance of a subsequent stimulus (masking stimulus) provides an estimate of the maximum functional (i.e., the information can be processed) flow of information through an individual's perceptual channel. The measurement technique that has been employed in these investigations involves the quantification of the amount of information carried by each stimulus in terms of bits using Shannon's mathematical theory of communication (Shannon, 1948).

The investigations which have been conducted at Western Michigan University during the past two years indicate that there is considerable variability in the rate of information processing among college students and among children in the later elementary grades. In addition, these investigations have produced relatively high correlations (ranging from -.29 to -.65) between the information processing rate of common and uncommon words and reading achievement scores (Wilkins, 1968). These correlations are fairly consistent with the findings of Gilbert (1959) indicating that a substantial amount of the variance in reading scores can be accounted for information processing rate.

Until recently, relatively little attention has been paid to the relationship between social environment and basic perceptual processes. As Cynthia Deutch observed, "perception has traditionally been regarded as a function quite independent of one's over-all social milieu, an assumption which is open to serious question." (Cynthia Deutch, 1967). Since the variable "processing rate" provides one conceptualization for "slow learning style" an investigation of the claim in the literature that low SES children exhibit this behavior was considered useful.

study was undertaken in order to answer the following question:

Do children reared in low SES environments exhibit rates of cognitive functioning on visual recognition tasks which differ from children reared in middle or high SES environments?

B. PROCEDURES

1. Subjects

The subjects for this study were selected from a city which has a substantial inner-city disadvantaged area. Subjects were selected from an advantaged (middle-upper class) school and a disadvantaged (lower class) school. All subjects were in the first grade. Thirty subjects were selected from each school.

2. Measurement of the Dependent Variable

The estimation of processing rate was accomplished with the use of a Gerbrans 2-field tachistoscope. This instrument permits a visual stimuli to be presented in intervals ranging from 1 msec. to 1,100 msec. in either of the two stages of the device. Using the dials on a timer, the experimenter can control the duration of exposure of field one, field two, and the pause between fields one and two. For example, the timer can be set to provide an exposure of 40 msec. in field one, a twenty-three msec. exposure followed by 15 msec. exposure in field two. The stimuli to be presented in the two fields is manually inserted into a holder at the rear of each field.

Since the tachistoscope which was to be used did not have fixation points, it was necessary to build them into the tachistoscope. This was done by cutting strips of luminous plastic into strips of red plastic. The strips were painted with flat black paint with an area of 2 mm left unpainted. A flashlight bulb was installed above each of the plastic strips causing two dim red squares to appear above and below test stimuli. The fixation points enable the subject to orient his gaze inside the tachistoscope.

Basically, the measurement procedure consists of presenting an image in field one for a fixed length of time. This image will be referred to as the test stimuli. After the termination of the test stimulus, there occurs a pause at which time no image appears. The duration of this pause is decreased during the testing procedure. Following the termination of the pause (which will be called the inter-stimulus interval), a second image is presented. This image is the noise stimulus. The information processing rate for a subject is obtained by locating the point on the time scale at which the inter-stimulus interval is too brief for processing of the test stimulus. Thus, the visual information processing rate for a subject is his maximum rate of handling visual information.

The first step in using the tachistoscope for this study was the selection of the test stimuli. Prior investigations at Western Michigan University have involved letters (Travers, Bosco, 1967), words (Wilkens, 1968), and numbers (Bosco, Travers, Wilkins, 1968).

After considerable trial and error with various stimuli, four common geometric shapes were selected: circle, star, square, and triangle. Since there were four stimuli and the probability for any of the stimuli to be transmitted was .25, the information carried by each was 2 bits.

The shapes have the following characteristics:

1. They can be discriminated by first grade children. Pilot work with disadvantaged children indicated that disadvantaged first-graders could discriminate these shapes.
2. These four shapes maximize inter-stimulus dissimilarity. A diamond, for example, was rejected since it would be confused with a square.
3. In order to promote comparability among stimuli, all figures used were closed figures.
4. All figures were symmetrical.
5. All figures were solid white on a black background.

Although the selection of the test stimuli required an appreciable expenditure of time, the development of the noise stimulus posed a considerably more complex problem.

Numerous noise patterns were examined and discarded. Some were discarded because they failed to effectively mask the test stimulus. Others were discarded because they tend to bias responses toward one of the test stimuli. One discarded stimulus, for example, contained two semicircles and tended to bias the circle response. Another pattern that was discarded was a random pattern of white light spots. This pattern did not mask the test stimulus. It seems essential that the masking pattern contains, in the target area, fifty per cent light and 50 per cent black. Also, there should be no large areas of white or black--such areas facilitate the structuring of the test stimuli. The pattern which was eventually selected was a complex design, constructed so that it contained none of the geometric symbols used as test stimuli for this study.

Another of the critical problems which is involved in the techniques of assessing processing rate is the scaling of the intervals to be used between the test stimuli and the masking stimuli. It is important that testing begin at a point where success is 100 per cent for each subject. During pilot investigations with first graders, it was observed that the schedule that had been used with older children was inappropriate. This schedule began with 60 msec and decreased in intervals of 6 msec. to 6 msec. In order to begin at a level above threshold, it was necessary for some children to begin above 100 msec. Since the tachistoscope can be varied only in units of 10 above 100, it was decided to adopt a pattern of decrements of 10 so that the scale would proceed with a consistent interval. When testing the first graders, two schedules were used. Schedule A ranged from 90 to 0 in intervals of 10. If subjects were making sufficient number of errors on initial levels of schedule B for a threshold identification, then schedule A was used. Schedule A ranged from 190-100.

The general nature of the experiment was described to each subject, who was also given a card with the 4-test stimuli to be used printed on it. All subjects were given 4 trials with each of the test stimulus alone, followed by an additional 4 trials with the blocking stimulus presented after an interval of 20 msec. In addition, each subject was given 4 trials with the blocking stimulus immediately following the test stimulus in order to familiarize them with the effect of the complex stimulus. It was explained to the subjects that they should guess if they could not recognize the letter presented. The sequence, dark field--test stimulus--dark field--noise stimulus--dark field, was triggered by the subject pressing a switch. Between trials, subjects were asked to look away from the apparatus into the dimly lit experimental room. Subjects were instructed to respond after each trial. If they did not feel certain of the identification of the test stimulus, they were instructed to guess. Requiring subjects to respond each time controls for individual differences relative to willingness to respond given some doubt about the accuracy of the response.

Each test stimulus was presented for 5 msec. followed by a dark field varying in duration from 90 msec. to 0 msec. The dark field was followed by a blocking stimuli presented for 10 msec. The test and blocking stimuli appeared between two dim red markers 2 mm in diameter.

The test stimuli were presented in 8 blocks of 8 stimuli in random order within each block. The first eight stimuli were presented, followed by a dark field of 90 msec. The dark field was followed by the complex design. Subsequent blocks will have post-exposure dark fields of 80, 70, 60, 50, 40, 30, 20, 10 and 0 msec.

B. RESULTS AND DISCUSSION

Table One provides a description of the two groups relative to age, SES, and sex.

TABLE ONE

Description of the Sample

	Low SES School	High SES School
Age	$\bar{X}$ = 85.17 months (SE_m= 1.1)	$\bar{X}$ = 85.07 (SE_m= .8)
SES	$\bar{X}$ = 14.63 (SE_m= 1.0)	$\bar{X}$ = 54.14 (SE_m= 4.7)
Sex	16 boys 14 girls	14 boys 16 girls

(SE_m=Standard Error of Mean)

This table shows that the two groups were comparable with regard to age and sex, but differed considerably on SES scores. Comparing SES $\bar{X}$s for the two groups provided evidence that the sample selection was accomplished in such a way as to provide two groups of differing social classes. The similarity of groups on sex and age provides control on these variables. Social class was quantified using Duncan's scale (Reiss, 1961).

For each protocol, a threshold was established by selecting the highest level at which the S made at lease three incorrect responses. After thresholds were marked on the protocols, the number of errors above the threshold were counted and converted to percentages, i.e. the percentage of total responses above the threshold which were incorrect. This percentage may be considered as an index of the "cleaness" of the protocol. The lower the percentage of errors above the threshold, indicates a sharper break in correct and incorrect responses. The percentage of errors above the threshold for the two schools were: Low SES school - 25.88%; High SES school 17.21%. These percentages indicate that the low SES subjects tended to produce a somewhat "dirtier" protocol than the high SES subjects. In no case did the break between the correct and incorrect responses appear so fuzzy as to make the designation of a threshold silly.

The protocols were subjected to one additional analysis in order to furnish evidence on the stimuli which were used in the study. The frequency of errors for each of the four stimuli and the frequency of the incorrect use of the word "square", "triangle", "circle", and "star" was determined. This analysis did not reveal any problems with the selected stimuli.

The differences between the two schools on information processing rate were analyzed using a t model. This information is contained in Table Two.

TABLE TWO

Comparison of Processing Rate in High and Low SES Schools

	Mean Processing Rate	Standard Deviation	Standard of mean	Significance of Difference in Means
Low SES School	70.33	51.96	9.65	$t = 10.931$ $p < .001$
High SES School	33.48	29.75	5.52	

Considerable discrepancy exists between the means for the two groups. The mean processing rate for the low SES group is more than twice as slow as that for the high SES group. While the average child in the high SES group could process the stimulus in about 33 msec. the average low SES child required 77 msec. There was more variability in the low SES group than in the high group. An F test of the ratio of the variance from the two groups resulted in a F = 3.05 which was significant beyond the 2 per cent level. The null hypothesis was tested with the t model for unequal variances. This t value was considered significant.

In order to examine the data from a different perspective a regression analysis was undertaken with processing rate as the dependent variable and age, sex, and SES as independent variables. Table Three shows the results of this analysis.

TABLE THREE

Beta Weights and Multiple Correlation Coefficient for Processing Rate with Sex, SES, and Age as predictors

Beta Weights			Multiple Correlation
Sex	SES	Age	
-6.4977	-.4947	-.8442	.31

This analysis reveals that the use of three predictors accounts for about 10% of the variance in processing rate. Ninety percent of the variability is explained by factors not included in the above model. The standard error of the estimate was 43.80. The correlations for each predictor variable with processing rate were as follows: Processing rate with sex -.06; processing rate with age -.08; processing rate with SES -.29.

This study has provided answers (of varying degrees of certainty) to the following questions:

1. Is it possible to test young children - especially young children of low social class - using the tachistoscope? The experience in this study indicates that the answer to this question is yes. Although the testing procedures require considerable cooperation and the careful following of instructions, it was necessary to reject only two out of the sixty-two subjects selected.

Observations of these subjects who were tested convinced us that young children could function with the tachistoscope on the tasks we developed.

2. What stimuli are appropriate for testing young children? After several months of pilot work, the four stimuli were used in this study. All children were able to recognize these stimuli. Analysis of the protocols indicates the stimuli functioned as we hoped they would.

3. Do children from a low SES background exhibit slower visual processing rates than children from high SES backgrounds? Yes, children from low SES backgrounds do exhibit slower processing rates. Two qualifications of the statement must be made. Inspection of the standard deviation shows that there was some overlap between the two groups. Some disadvantaged children exhibited faster processing rates than their advantaged colleagues. Also the regression analysis serves to indicate that there well may be other variables which explain more of the variability in processing than does social class.

Note

The data reported in this paper represent one subset of the data collected for the U.S.O.E. supported study. Upon completion of all aspects of the study the final analysis and interpretation of the data will be disseminated.

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